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UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item: D.14

Hungary

BUILDING OF INDUSTRIAL PLANTS WITH SPECIAL ATTENTION TO PREFABRICATED ELEMENTS

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BUILLING OF INDUSTRIAL PLANTS
WITH SPECIAL ATTENTION TO PREFABRICATED ELEMENTS

by

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1./ Preambles of the prefabrication of reinforced concrete in Hungary.

a./ Following World War II. a speeded up industrialisation has been started in Hungary. Being primarily an agricultural country with insufficient heavy industry, there was little experience in the erection of industrial plants: forces for planning and building were few. We did not have enough basic materials of industrial investment, chiefly rolled steel and wood for the shutterings of monolithic reinforced concrete constructions. We had to omit the intermediary stages of industrial development, as observed elsewhere and the demands of a growing industry had to be met by immediate action.

b./ In these circumstances, the attention of Hungarian architects and engineers has been directed - perhaps for the first time in the history of architecture - towards precast reinforced concrete structures. We developped in the course of the last 15 years the structural types of industrial buildings of prefabricated reinforced concrete. These results are largely quoted by technical papers and are internationally well known.

c./ We believe that countries in the course of industrial development might well utilise our experiences in this field.

2./ The conditions of industrialisation.

a./ Hungary possessed a heavy industry before the war, but the shortage of coal and ore deposits hindred its development.

b./ The difficulties of the building industry are determined by the deficiencies of the heavy industry, namely in two respects. Firstly, there is not enough rolled steel. The limited stock of rolled steel and of sheet metal are needed in other fields. Building has to reckon with rolled bars of reduced quality, an inavoidable final product of the steel industry. Meanwhile, should cement production stay below a suitable level, there is enough raw material to raise the output. These facts pinpoint reinforced concrete as the principal material of industrial architecture.

c./ Due to the initial lack of the heavy industry, scores of industrial buildings are needed for it, for power production and for plants of basic material production, with crane equipped shops of large spans, etc. - therefore the tasks are diverse and complicated. There are no means to learn by stages, how to build: easy jobs appear intertwined with complex ones. The situation

is aggravated, as the exigencies of the speedily developing industrialisation are differentiated, even within local aspects. To reach a balanced occupation of all inhabitants from territorial point of view and also a well proportioned progress, industrial centralisation has to be considered, though slightly in the beginning.

d./ The insufficience of timber for the building industry is world wide and increasing. The international market price of lumber is in constant rise. The deficiency compels the methodically planning architect to forego the traditional means of erecting industrial buildings of monolithic structure. To-day, even countries richest in wood turn - later, but just like the others - to the prefabrication of reinforced concrete structures. Finland and Sweden - which are richest in timber production - use precast building methods on a large scale. The U.S.S.R. produced in 1954 about 1,300,000 m3 of industrially prefabricated reinforced concrete elements: this quantity has been raised in 1960 twentyfold, i.e. to 26,000,000 m3.

e./ Considering the building industry of developing countries, an important factor has to be faced, i.e. they are in most cases unprepared to meet the speedily increasing demands: they lack skilled forces for the erection of industrial constructions, there is a general lack of experience.

f./ Prefabrication of reinforced concrete elements are carried out in special plants, or, as we shall detail, on the building site. The more developed stage of prefabrication belongs undoubtedly to the specialised plant, able to handle high qualities of concrete and steel, utilising their ultimate strength. We have to consider simultaneously, that countries in the course of industrial development are in general - due to their relative lag - deficient in funds. Their status becomes somewhat strained in this stage of progress, being compelled by the establishment of a balanced and sufficient basic industry to erect in the same period many industrial plants of most varied kinds. These circumstances strain heavily all resources. Thus, relatively limited resources are left to develop the building industry, which is a means and not the goal of industrialisation. Therefore the strictest economy has to be maintained in this branch: there are no means for large investments, as for fully equipped prefabrication plants with specially designed machinery. Full amortisation of investments for building industry plants are among the longest, as it is widely known. But the prefabrication on the site - contrary to industrialised prefabrication serving the entire building industry - requires only inconsiderable investments. Their initial exigencies are primarily lifting devices of relatively small cost, largely differing from the producing and conveying machinery of industrialised plants.

3./ Prerequisites and realisation of reinforced concrete prefabrication.

a./ To begin with, traditional methods of projecting industrial architecture have to be revised. At the planning of the technological procedure the exigencies of building construction have

to be taken more in consideration. Prefabrication, even on the site, assumes and expects a certain amount of serial production. The possibility of creating identical elements has to be ensured by grouping buildings and by housing different technologies in the same group, as well by the prevailing principles of volume-shaping, concerning the whole plant. Uniting structures, possibly into a single block is - as we have experienced - technologically just as advantageous, because internal delivery becomes shortest and facilitates later regroupments and new technologies. Increased standardisation of structural dimensions is neccessary for the repeated use of building elements. We have to regulate the dimensions of spans, widths and heights of all main structural parts of the buildings, in accordance with previously established principles. In Hungary we achieved by this method of standardisation of frames regularised spans of 6, 9 and 12 metres and this implies the thorough standardisation of roofing structures, i.e., their dimensions. Typification of elements, as a result of standardised dimensioning is the major requirement of prefabrication, which becomes a high grade and economical building method by the single means of serial production.

b./ Judged from the point of view of progressive industrialisation, prefabrication of reinforced concrete elements on the site is an intermediary stage between monolithic construction and industrialised prefabrication. But prefabrication of the site-type is - contrary to the industrialised - very adaptable to different loads: all main parts of load-bearing structures can be cast on the site as they need no transportation. In most cases their weight is under 10 tons. Smaller elements, of 1-2 tons can be produced in the proximity of the site, by a temporarily erected plant, equipped for serial production and preferably roofed, protected from adverse weather.

c./ The mechanisation of the construction has to be twofold. Concrete mixers, woodworking and welding machines, simpler kinds of gantries are neccessary for the aforesaid prefabrication on the site. This small mechanical equipment is of low cost and of short amortisation. Cranes for building purposes are of established types. In the first place we need "universal" cranes - not bound to tracks - on wheels or of the caterpillar type, of 5-10 t capacity. In special cases - for large capacity /f.i. at power-plants/ so-called lifting-towers or rigs convey up to 50 tons. When neccessary, pulley equipped primitive wooden constructions suffice. By this method were erected the prefabricated reinforced concrete shops of the Machine-Tool Factory in Korea.

d./ For connecting the elements lifted into place fully developped methods have been established. Characteristic are the so-called "dry-connections", i.e. those with immediate load-bearing capacity, whereby lifting and placing call for little time, and by rational assembly the demand for lifting devices remains small. For instance, the relatively highly developed building industry of Hungary produces satisfactorily with 40 caterpillar-cranes, though 80 % of our industrial buildings are erected by prefabrication.

e./ Because of serial production, mechanisation, less skilled workers and speeded output, the method described above requires a more carefully scheduled organisation. Construction and design have to be strictly coordinated. One has to reckon with initial difficulties due to the spreading of prefabrication, nevertheless, as is proven by Hungarian experiences, the new method was adapted within one or two years and became an indispensable factor of the building industry.

4./ Advantages of reinforced concrete prefabrication.

a./ As stated above, prefabrication on the building site started as a reasonable stop-gap. Circumstances motivating prefabrication lessen sooner or later, according to the progress of the given countries, but experience proves that this method remains in widespread use. Prefabrication has many advantages compared to monolithic and shuttered construction. These comparisons result in the following conclusions :

b./ With prefabrication, scaffolding becomes superfluous, particularly at levels above 5 metres, for the placing of reinforcement and concrete, Scaffolding requires considerable material, careful execution, skilled labour : it is costly as a method. It is well known that the quality of monolithic reinforced concrete constructions depends mainly on a correct scaffolding which has to be kept up during 40-70 % of the entire construction period. Important scaffolds require especially skilled workers.

c./ With prefabrication the construction of moulds is also advantageous. The average shuttering can be utilised at best 3 to 5 times. Though moulds for prefabrication are somewhat costlier than average shutterings - being sheet-iron covered wooden structures or made of concrete - and are stronger built, but by previously designed construction and by more careful maintenance they last much longer and can be utilised at least 30-50 times. As they are placed at soil level, they are easy to reach, and further, their construction and dismounting does not cause losses. By prefabrication the need for scaffolding and shuttering material decreases 80-90 % compared to monolithic and shuttered methods.

d./ As the placing of reinforcement and of concrete takes place at soil level, the operations and control are easy. The product is of greater precision, consequently the needed tolerances are less.

e./ Due to the former reasons we are in a position to utilise materials of higher quality. The quality of concrete depends mainly on the aggregate, the cement and the water-coefficient, but the circumstances of placing and vibration, i.e. the accessibility of the formwork is by no means secondary. With prefabrication, work and control becomes easy. To indicate the resulting economy, we mention as an example, that the dead load of a main roof truss of 12 m span decreases 50 % when made of concrete of 420 kg/cm2 cube strength, instead of a concrete of 140 kg/cm2 cube strength. This is also of fundamental consequence regarding lifting devices and the dimensions of all load-bearing structures.

f./ With monolithic structures, because of difficult circumstances of erection, we have to adhere to cross-sections of utmost simplicity, while in the course of prefabrication we are enabled to adopt elaborate cross-sections, in the most advantageous and systematic form, as derived from statical computations. Thus, by the building technique we obtain the practical I and T sections, as well as moulded and latticed girders. At the traditional monolithic method the fully quadrangular section is solely employed, in our demonstrated figures the more subtle and latticed forms prevail only. These slender and light structures are also becoming factors of spatial composition, they can compete in many cases with the aspect of steel structures.

g./ The organisation of the prefabricating plant is an easy task and we reach without difficulties an ordered working site and planned output.

h./ By prefabrication, the total number of workers decreases, compared to the traditional methods: this holds good especially to skilled workers. We can dispense largely of carpenters and scaffolders. These, perhaps the most skilled and most valuable men of the building industry should be employed as foremen of prefabricating units.

j./ The constructional time-schedule can be considerably shortened because of a better organisation, simultaneous job-distribution and mechanisation.

k./ Under unfavourable climatic conditions prefabrication diminishes to a certain extent the seasonal character of the building industry, results in a more even employment of workers and indirectly in further cut on time-schedules.

5./ Conclusions :

a./ The constructional principles and the sphere of application of prefabrication are of course still in development. In our opinion, prefabrication calls for adherence to the following two basic principles :

b./ Prefabrication can be applied with success only if there is a possibility for serial production.

c./ We must endeavour to obtain simple connecting-devices for elements of economical cross-sections.

...

6./ Examples of industrial buildings, designed and planned in Hungary for prefabrication on the building-site:

a./ Bale-storage building of a paper-mill. /Fig.I./
By IPARTERV /Planning and Designing Office for Industrial Buildings, Budapest./
Ing. B.Takátsy.

b./ Machine-shop of a shipyard. /Fig.II./
By IPARTERV.
Ing. M.Gnädig.

A most typical system of industrial hall-structures. For gantry-cranes of 24 m, breadth 26,2o m, column distance 9 m, height 11,20 m.

c./ Erection of roofing of a cold-storage plant. /Fig.III./
By IPARTERV.
Arch. L.Csaba, Ing.I.Komlóssy.

Roofing panels on upper flange of main girders; suspended double ceiling carried by lower flange.

d./ Nitrogen fertilizer factory of a chemical combine./Fig.IV.V./
By IPARTERV.
Arch.L.Bajnay, Ing.M.Gnädig.

At the designing of the 24 different industrial buildings of this combine, we succeeded by careful and initial investigation in obtaining a thorough reduction of aggregating elements, to a minimum. By standardisation of hall-structures, the entire combine had been erected with four types of reinforced concrete trusses for roofing, i.e.of 12, 15, 18 and 30 m spans, and by a single kind of roofing-panel of 6 x 1,50 m. Exterior wallings are of light concrete panels of 1,20 x 6,00 m.

e./ Thermal power-plant of 200 MW output. /Fig.VI./
By IPARTERV.
Ing.Gy.Mátrai.

The structure consists of columns of light cross-section and of latticed girders. The lifting of the 30 t elements required special structures of provisional character.

f./ Thermal power-plant. /Fig.VII./
By IPARTERV.
Ing.Gy.Mátrai.

All structural elements of the plant - except the heavily charged intermediary floors and coal-bunkers - had been prefabricated at the site. Prefabrication progressed in periods, due to the great loads of structural elements. The wall-panels had to be erected before the fabrication and lifting of roofing-parts, as all these had to be cast practically on the same spot.

g./ Erection of arched roofing in a machine-tool factory./Fig.VIII./
By IPARTERV.
Ing.L.Garay, Ing.J.Kellner.

Liaisoning arches with tie-rods and latticed beams, we obtained the represented latticed main beams of extraordinary economic features. At the lifting and placing of this element the conditions of stability must be strictly observed.

h./ Workshop of a cable-factory. /Fig.IX./
By IPARTERV.
Ing.Gy.Mátrai, Ing.K.Pászti.

All elements had been prefabricated on the site. Roofing of barrel-vaulted shells of 6 cm, with tie-rods: each shell is of 33,35 x 6,80 m surface and of 57 t weight. Hollow columns of 22,7 tons.

i./ Railway-Car Factory. /Fig.X./
By IPARTERV.
Ing.M.Gnädig.

The multistoried and prefabricated shop with overall floor

charge of 2 t/m2 comprises, as structural parts, light and continuous columns, main girders and floor panels. Liftings were carried out by a caterpillar-crane of 10 t and of a leverage of 18 m.

k./ Universal industrial building. /Fig.XI.XII.XIII./

By IPARTERV.
Arch.L.Bajnay, Ing.M.Gnädig.

A typified structure, suited for all-round utilisation. Columns on a net of 9/9 m. The building is suitable for all functional demands, from storage to the most exacting precision instrument manufacture. It is easily suitable for industrial or in-situ prefabrication. The structure comprises the following elements:

I. Reinforced concrete roof-slab of 1,00 x 3,00 m.
II. Intermediate roof-truss of 9 m /T section/.
III. Roof-truss of 9 m span /or others of 6 or 12 m spans, thus suiting distributions on nets of 6/9 or 9/12 m/.
IV. A single type of column.

l./ Railway-Car Factory in Perambur. /Fig.XIV.XV.XVI./

By IPARTERV.
Ing.L.Garay.

In the State of Madras /Republic of India/ the buildings of the Railway-Car Factory of Perambur had been erected on the basis of designs made in Hungary, utilising prefabrication of reinforced concrete elements, made on the building-site. According to the tender, steel structures had been considered. In the course of international biddings, the Hungarian tender offering reinforced concrete instead of steel was recognised as the most advantageous.

The entire prefabrication was carried out by Indian workers, superintended by two Hungarian engineers. The prefabricating plant was next to the building-site: the upper limit of loads was 10 t. Lifting and jointing of elements was done by two excavating cranes, one of 30 t, the other of 5 t capacity.

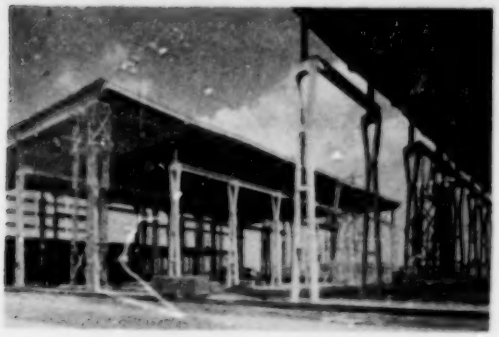

Fig. 1

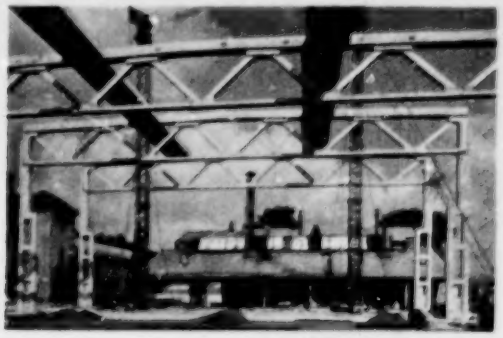

Fig. 2

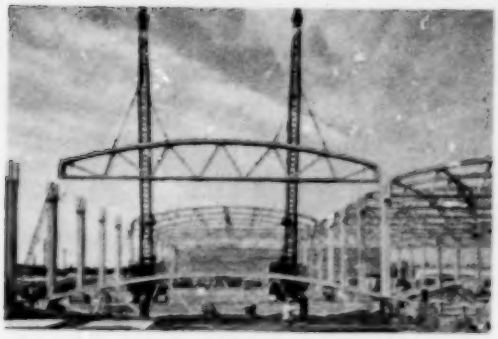

Fig. 3

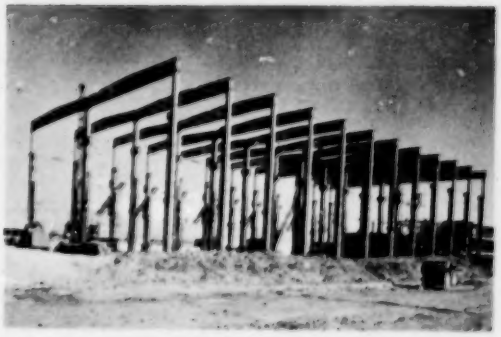

Fig. 4

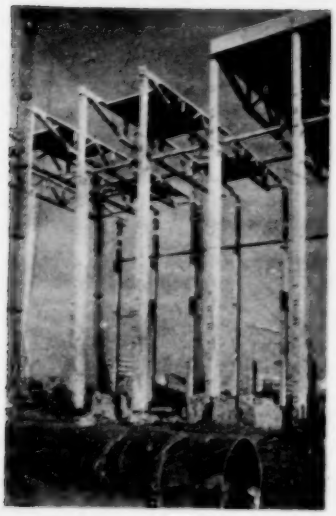

Fig. 5

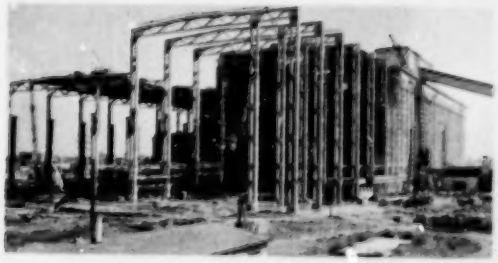

Fig. 6

Fig. 7

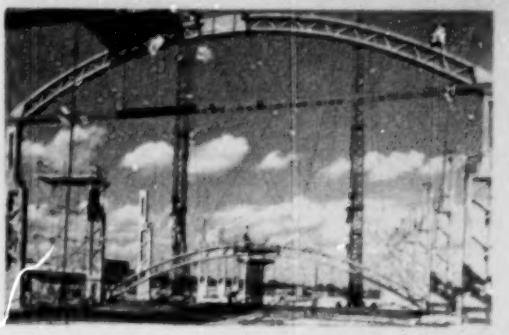

Fig. 8

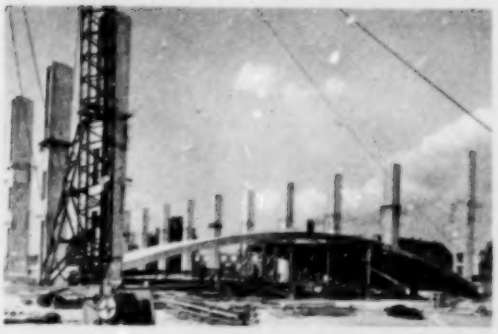

Fig. 9

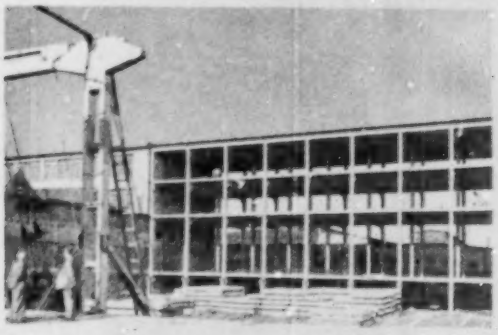

Fig. 10

Fig. 11

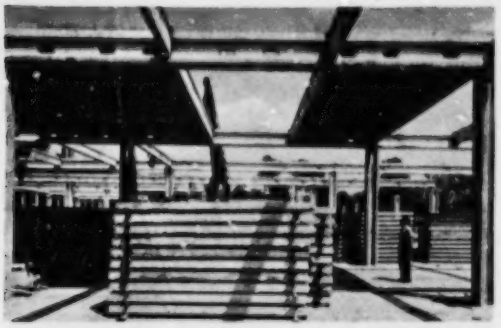

Fig. 12

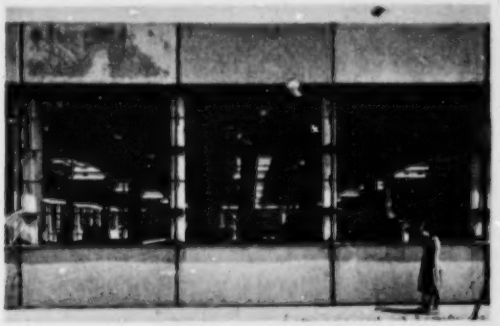

Fig. 13

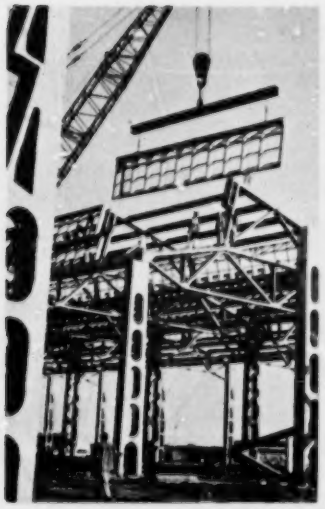

Fig. 14

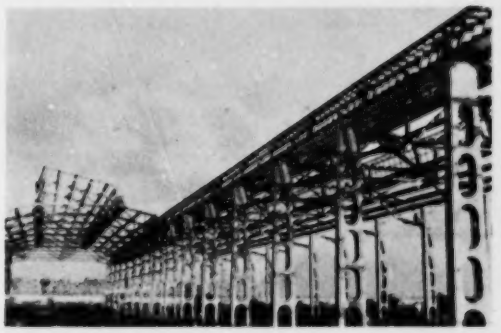

Fig. 15

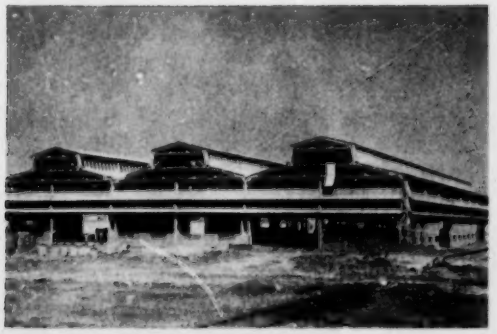

Fig. 16

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SUMMARY

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Hungary

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by

Dr. Jenő SZENDRŐI
Planning and Designing Office for Industrial Buildings
"IPARTERV"
Budapest, Hungary

Summary

a./ Countries in the course of speedy industrial development do not possess in general within their boundaries an established and sufficiently productive heavy industrial basis. They endeavour to meet the maximum of their requirements by home produced material: this concerns particularly the building industry, which is a means and not the goal of industrialisation. The strictest economy has to be observed: there are no means for large investments in this branch, such as prefabricating plants or specialised machinery. The amortisation of investments in the building industry is of the longest range.

b./ The basic building materials of industrial investments are rolled steel and lumber for industrial halls and shops of reinforced concrete structure, both hard to procure. We find therefore prefabrication of reinforced concrete elements on the building site as a suitable method for industrial buildings, requiring but small investments. In Hungary, 80% of industrial buildings are currently erected by this procedure.

c./ Advantages of prefabrication on the site: 80-90% economy in scaffolding and shuttering, the concrete is of better quality and the resulting structures are of more economical dimensions. Less workers are needed - especially skilled ones - as with traditional building methods. The time-schedules of erection and of the jobs decrease.

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Agenda Item: D.9.3

Czechoslovakia

NEW ENGINEERING TECHNIQUES

By Vaclav CAPEK,
Head of Department of Engineering
Technology Research, National Research
Institute for Materials and Technology
in Prague, Czechoslovakia

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NEW ENGINEERING TECHNIQUES

Václav ČAPEK, ČSSR
Head of Department of Engineering Technology Research,
National Research Institut for Materials and Technology
in Prague, Czechoslovakia.

1. Introduction

(a) Engineering techniques and their further development are to a great extent influenced by the steady advance of automation and mechanization.

(b) The automation and mechanization of the mechanical engineering industries are undergoing an impetuous development in all countries and attention is in the first place concentrated on the classical techniques of machining and working, i.e. on machine operations.

(c) A certain lag in the progress of automation and mechanization can be observed in assembly and manual work generally and especially in small-lot and piecework production. Therefore for the present time the mutual relation of the four major engineering techniques - i.e. machining, chipless forming (pressing and forging), welding and manual and assembly work - should be taken for a criterion of the level of engineering techniques.

(d) The technological set-up is the basis of production and will remain so in the future. It has a deciding influence on the level of engineering production and should create such conditions as will enable the production to go on in all its stages in the most economic manner, to ensure the planned volume of production and to guarantee the top quality of products.

(e) In general it is possible to say that the technological level of mechanical engineering production is determined in the first place by:

(i) directing research and development work towards the advancement of the technological level of production;

(ii) introducing highly progressive techniques and efficient organization in the production processes of mechanical engineering industries;

(iii) the level of production machinery and equipment and the load factor.

(f) The elaboration of the engineering techniques development problems must proceed in the closest connection with scientific research. Also operation research is very important, especially the cost analysis of preparing times in machine operations.

(g) An accomplished analysis of technological processes from the point of view of the preparing time costs enables us then to set down several basic principles for the mechanization of clamping and gauging operations in machining. In the Czechoslovak mechanical engineering industries such thorough analyses have been performed and now it can be said that in some fields which will be discussed further this question has already been solved, to a great extent successfully. It is in particular in the fields of machining, chipless working and welding where mechanization has made the greatest advance.

2. Machining

(a) In machining, mechanization and automation is represented by programme-controlled machine tools.

(b) Piece-work and small-lot production require a "flexible" automation, i.e. easy, speedy and economic methods of adapting a fully or partly automatic machine to the production of another type of workpiece.

(c) One of the new tendencies which is being applied in the automation of this type of production is the introduction of speedy adjustable machines of which at present the programme-controlled machine tools are the representatives.

(d) The programme usually contains information on the shape and size of the workpiece, on machining techniques, cutting conditions, and other necessary production functions. For recording the programme and supplying it to the machine different media can be used, e.g. punch card, punched tape, magnetic tape with pulse or phase modulated record etc.

(e) In general it is possible to say that the greater number of functions such a programme-controlled machine is able to automatically perform the more intricate it is and the heavier demands it will make on maintenance work whereas the actual attendance work becomes much simpler. For the full utilization of programme-controlled machines a new organization of production is necessary; the organization must ensure continuous running of production so as to avoid time loss. These machines can find advantageous application above all in the production of intricate-shaped workpieces where much machining is needed and which make heavy demands on accuracy.

(f) According to the accomplished economic analyses the programme-controlled machine tools exhibit as a rule a high efficiency in many cases even in case when one operator runs only one single machine. E.g. the semi-automatic vertical copying lathe SPK 63 shows in comparison with the conventional vertical lathe with a table 800 mm dia. an increase in productivity of 162 per cent. In this case the time of investment returnability is 2.15 years.

(g) The efficiency of the programme-controlled machines increases substantially when they are combined into technological groups or lines thus enabling one operator to run more machines.

(h) Some programme-controlled machine tools of Czechoslovak make have already been working for longer periods of time in engineering works and many more types of programme-controlled machine tools reached the stage of development or in some cases prototypes are available. These are mostly machines provided with digital control and representing altogether more complicated programme-controlled machine tool types. The application of digital control provides the possibility of continuous movement of the tool allowing an intricate plane or space trajectory. In addition to the control of the direction and sense of movement and the length of the trajectory, i.e. to the determining of the shape and size of the workpiece, it is possible to apply digital control also to the feed and cutting speed. The movement of the tool or of the workpiece is set out in the programme by a series of numerical data which are determined from an engineering drawing of the respective part and supplied to the machine recorded e.g. on a punched tape. This numerical information carries the working

programme of the machine and represents a formula according to which a special electronic computing control equipment generates the prescribed number of electrical impulses. The character, number and rate of the impulses controls both the feed and the trajectory length of the tool or workpiece.

(j) The advantages of programme-controlled machines are as follows:

(i) One worker can run several machines;
(ii) The programme can be prepared separately apart from the machine;
(iii) Products are geometrically identical;
(iv) The preparing times can be minimized; tool performance can be utilized to the full;
(v) Several workpieces can be machined simultaneously in one cycle
(vi) The programme-control enables a speedy setting-up and therefore these machines are fit for application both in piece-work and small-lot production;
(vii) It is possible to store the tape with the recorded programme for future needs.

(k) The application of programme-controlled machine tools marks the principal trend in introducing automation in the field of piece-work and small-lot production. The preparation of production is changed into programming where machining conditions must be determined separately (i.e.apart from the machine); this method demands a substantially higher qualification of technologists in charge of programming. Grouping together workpieces with similar production technologies facilitates the organization and preparation of production for different machine tool types.

(l) In order to increase labour productivity programme-controlled machines are being gradually equipped with automatic clamping and loading devices, storage bunkers, tool replacing devices, accurately adjustable tools for speedy elimination of edge wear and with automatic gauging.

(m) The efficiency of programme-controlled machine tools has not only the direct effect of increasing productivity but also secon-

dary effects that can not be taken into account in the evaluation of total costs savings. The most important of these secondary effects include: increase in the all-plant productivity, attainment of higher production accuracy, improvement of labour conditions, savings of labour and the possibility of dividing the whole-year output into smaller batches.

(n) The programme-controlled machine tools represent a new trend in the production technique which is progressive; it is therefore necessary to prepare further conditions for its successful introducing into production.

3. Chipless Working

(a) In the field of chipless working of materials, one of the problems that have been studied in Czechoslovakia, is the question of production techniques of parts with a through-hole. A new process of manufacturing such parts has been developed and tried out in practice. The new technology is covered by the Czechoslovak patent No.91509. More than 90 per cent of material are utilized when the process is applied. In comparison with machining approx. 62 per cent of material are saved. This technology has been tried out with success and used for producing small parts of motor cars, tractors and bicycles. The possibilities of its application are, of course, much wider.

(b) To produce parts with a through-hole, it is necessary, first, to prepare semi-products, i.e. welded rings of wire of desired cross-section. Carbon steels or low-carbon alloy steels with guaranteed weldability are being used. If the part is held in another clamp and is, itself not subjected to tensile stresses, it may be pressed from welded rings. Otherwise, the rings must be welded; butt-welding is used. Flashes resulting from welding are removed by pressing the weld in a die and by trimming the side-flash.

(c) Wire having a cross-section in the desired shape and size serves as base material. In order to keep the volume of the material within close tolerance limits, such as are required in cold working, it is necessary to use wire of H 11 tolerance. Preparation of rings can be best carried out on machines (wire or spiral spring coiling machines). The wire is wound to a helix; individual coils

are cut off and flattened to plane rings by pressure in the machine. Among the machines suitable for this work, we may mention e.g. Czechoslovak universal automatic spring-coiling machines AU 3 for wire of 0.8-3 mm dia., TAU 50 for 2-5 mm, or AU 8 for 3-8 mm dia. wires.

(d) Further preparation of rings consists in descaling (tumbling), degreasing and phosphatizing with subsequent impregnation of the phosphate layer with a lubricant. These operations are the same as in other cold working processes.

(e) The use of rings as a semi-product yields large material savings and a substantial reduction of working time. This process results in lighter stressing of the tool and thus its longer life. The circular or eliptical cross-section of the ring has the following effect: the working part of the tool, i.e. the punch and the die do not contact at the beginning of the working process the whole active surface of the ring, the contact being theoretically only in a circular line, so that the force needed to produce the plastic flow of material is considerably lower. Practical tests have proved that this process of working means a decrease of about 25 per cent in unit forming pressures when compared with the process employing slugs as a base semi-product.

(f) Another advantage of using rings as a semi-product is the fact that the edges of the extruded part remain slightly rounded and need not be subsequently chamfered.

(g) Mechanical presses are generally best suited for cold forming in dies because of their higher speed of forming and a greater number of strokes in comparison with hydraulic presses. The Czechoslovak LU type mechanical presses which are made for nominal pressures of 63, 100, 160, 250, 400, 630 and 1000 tons are best for this purpose. They are constructed from standardized groups and may be combined and suitably arranged for all sorts of characteristic pressing techniques.

(h) Most of the rotary-shaped parts may be produced directly by working close to the required shape and size. In some parts all that is needed is face smoothing or cutting of threads. The cold deformation increases the strength of material up to 60-80 kg/mm^2

so that heat treatment may be dispensed with. The extruded parts may be hard-faced by carburizing or quenching.

(j) As an example we may mention e.g. the production of gear rims for bicycles, which were formerly produced by machining forgings on automatic lathes. The costs of pressing from rings amount to only 40 per cent of the cost of the older production process.

Another example:

(k) One of very costly finishing operations is the smoothing of holes. An advanced technique for sizing and smoothing holes is represented by pushing a tapered broach or a ball through a hole of a smaller diameter. By pushing a tapered sizing broach surface finish of 0.1 - 0.2 μ can be attained. The operation takes only a few seconds. The necessary equipment is simple and does not require skilled attendance. This technique requires the straightness of the hole to be observed already in the preceding production operations. The wall-thickness should not vary along the length. It is also possible to make use of pulse-working for smoothing holes, when the tool (broach) is pushed into the hole by pulses and performs the following operations: rough-forging the hole connected with an effective strengthening of its surface, then finishing the hole by cutting off the allowance in several stages and final sizing and smoothing. For this technique the pulse-press LVI 50 is used.

(l) A similar technique is used for pressing the lining into the bearing bush. The lining material - a thin sheet up to 1 mm - is cut out, bent to shape and inserted into the rough-machined hole of the bearing bush with a tolerance of H 11 and with a surface finish of H_{sk} 25-50 μ. The lining is about 2-3 mm longer than the bearing bush and one side is flared so that it will be held by the front face of the bearing bush at the beginning of pressing. The longitudinal seam of the lining is not welded because the gap will be completely filled up by pulse-pressing. The forging-in of the lining is done by means of the tool described and on the LVI 50 pulse-press. The pressing operation takes only a few seconds. The precision is within the tolerance-limits of H6 - H7 and Hsk 0.02 - 0.05 μ surface finish is obtained.

4. Welding

(a) Welding is one of the most efficient joining techniques and its share in the mechanical engineering production will be steadily increasing.

(1) Arc Welding

a. Manual Welding

i. Though automation and mechanization of welding processes have made rapid advances, manual welding still plays an important part . This fact entails the necessity to increase the productivity of manual welding by increasing welding performance and depth of penetration.

ii. For this reason, in the Czechoslovak Socialist Republic, the EV-19 electrodes with a large yield of weld metal were developed and introduced into production. These are up-to-date high performance electrodes. Their higher welding performance is reached by means of a high arc voltage of 40 - 55 V and of an increased current density in comparison with electrodes of the classical type. The welding performance is 150-200 per cent higher than with normal electrodes. The speed of welding is 40-50 cm/min. Either D.C. power units with steep static characteristics or transformers with open circuit voltage of approx. 80 V are used as source of welding current.

iii. Deep penetration welding is another highly efficient technique of manual welding where high productivity is achieved by increasing the penetration depth in a chamferless joint gap. This welding technique is especially suitable for butt weld joints from 5 to 25 mm on rimming carbon steels containing up to 0.22 per cent of carbon. The savings in production costs in the case of butt joints amount to 50-55 per cent.

iv. Both these electrode types will substantially increase the productivity wherever favourable conditions for economical use of automatic arc welding machines have not been created or where automatic welding cannot be used at all.

b. Semi-Automatic and Automatic Welding

i. Automatic submerged arc welding is already well known. Recently even higher alloyed steels have been welded and gradually also submerged arc welding of aluminium is being applied in practice. A.C. is mostly used for this welding technique, D.C. is applied only in some special cases. The economic effect is greatest in the welding of sheets over 10 mm thick. The mechanical properties of the weld joints are equal to the base material characteristics.

ii. Automatic CO_2 shielded welding is rapidly becoming widespread in different branches of industrial production. It has some peculiar features in comparison with submerged arc welding. The CO_2 protective atmosphere has an oxidizing character and consequently some elements are burnt out. Therefore welding wires used for plain low-carbon steels must have increased contents of manganese and silicon in order to obtain the required composition of the weld metal. Welding wires of 0.8 to 2 mm dia. are used.

iii. CO_2 welding is suited for butt and fillet joints of up to about 15 mm thickness. The productivity in this field is about 50 per cent higher than in manual welding.

iv. Actual welding times in either of the two automatic welding techniques are on the average 10 times shorter in comparison with manual welding. An increase in productivity of labour as a whole is in most cases two- up to fourfold; this is due to relatively high preparing times which are higher than in manual welding.

(ii) Electro-Slag Welding

a. This method is economical for welding materials over 20 mm thick (thickness is practically unlimited). The weld pool which is formed between the two welded edges is shielded by molten slag and copper shoes are provided on both sided so that the pool cannot flow out. One or more electrodes, depending on the thickness of the material to be welded, are used. The electrodes have the shape of circular rods or strips. Welds are performed in a vertical position. The

advantages of this welding technique are great. The whole thickness of the material is welded in one single run. Electro-slag welding is used for welding the heaviest products such as e.g. thick-walled pressure vessels for the chemical industry, high-pressure boiler drums, heavy frames of forming machines where it has fully replaced the former heavy forgings or steel castings.

b. In the Czechoslovak industry the VUS-AS-4 type universal automatic electro-slag welding machine is used for welding in vertical position for wall thicknesses of 20 to 350 mm and weld lengths up to 5 m. In comparison with the present submerged arc welding techniques, the flux consumption of this new automatic welding machine is 20 times, electric power consumption 30 times lower and welding wire savings are 40 per cent. The productivity of labour is increased by 300-500 per cent. The automatic welding machine AS 4 replaces the work of 15 to 20 welders and, in the case of greater thicknesses, even of as many as 60 welders.

(iii) Resistance Welding

a. Resistance welding is the most efficient technique for joining materials; its use is now spreading even in production branches where formerly resistance welding had not been considered.

b. In production branches where welding had already for a long time played a decisive role, as e.g. in the automobile and railroad vehicle production industries, resistance welding is being applied in an ever increasing extent especially in the form of ultraspeed and multiple spot welding machines, welding presses mostly provided with electronic control equipment and with the possibility of programming the whole welding process and thus eliminating the influence of the human factor.

c. Mass production offers the most advantageous use of resistance welding. The application of programme-controlled automatic resistance welding machines is the way to high productivity and to the cutting down of production times.

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SUMMARY
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UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

SUMMARY

Agenda Item: D.9.3.

Czechoslovakia

NEW ENGINEERING TECHNIQUES

By Václav CAPEK,
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in Prague, Czechoslovakia

Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

NOTES

1. Papers selected for inclusion in General Sessions will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.

2. Papers selected for inclusion in Specialized Sessions will be available at the Conference in only one of the above official languages.

3. Summaries of all papers, as submitted by contributors, will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.

4. Papers and summaries will not be available for general distribution in advance of the Conference. They will be published in advance in limited quantities only for the use of delegations of participating governments and of other authorized participants. Post-Conference publication and general distribution of the Conference Proceedings will follow United Nations practices as laid down by the United Nations Publications Board.

SUMMARY TO THE PAPER "NEW ENGINEERING TECHNIQUES"

by Václav Čapek
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in Prague, Czechoslovakia.

(1) As the engineering technology is a very diversified and manysided discipline, this paper can deal only with some of its aspects, namely with machining, chipless working and welding.

(2) In machining, programme-controlled machine-tools represent a progressive technological tendency, particularly in small-lot and piece-work production. In the Czechoslovak industry the following types of programme-controlled machine-tools are produced and applied.

(3) Lathes

(a) Semi-automatic copying lathes of the SP 25, SP 31 and SPK 63 types controlled by means of punched card and stops.

(b) Lathe SN 55, turret lathe RPK 25, and vertical lathe SKJ 8A.

(4) Milling machines

(a) FB 40 V, FRO 8, FRM 6 types controlled by means of punched tape and stops with rectangular cycle.

(b) FB 32 type, with digital control, without stops, with rectangular cycle.

(c) FA 4 V type, with digital control, with continuous control of tool movement along an intricate trajectory.

(d) Plane-milling machine FRJ 5 with a digital phase system of continuous control.

(e) Vertical milling machines FA 5 V and FV 1000 with a continuous digital control system with stop motors.

(5) Other machines

(a) Co-ordinate table with automatic setting of coordinates, punched-tape controlled ISS-I.

(b) Horizontal boring and milling machine WH-100.

(6) As far as chipless working is concerned, a description is given of a technological process for producing parts with a through-hole - an original high-productivity technique. To establish this process, the following machinery is necessary:

(a) Universal automatic machines for the production of springs (0.8 to 18 mm dia.)

(b) Mechanical presses LU 63, 100, 160, 250, 400, 630, 1000.

(7) For the making of high-precision and smooth holes it is advantageous to make use of the LVI-50 pulse-press which is also

very well suited for the production of sleeve bearings with a lining of thin sheet.

(8) Welding in combination with chipless working and casting makes it possible, in the mechanical engineering industries, to go over to new, technologically advantageous design of machines and equipment to an ever increasing extent. In all countries the application of welding is on the rise. There is an effort in this country to facilitate welding to the highest degree by introducing automatic welding machines. For arc welding, the following types of automatic and semi-automatic submerged-arc welding machines are used:

(a) Universal automatic welding machine, type SUM-1000.1

(b) Universal heavy type automatic welding machine with continuous flux circulation, type SHR-1500 R

(c) Suspended automatic welding machine, type SHR-1500

(d) Welding tractor, type STK-100

(e) Automatic welding machine for staybolts, type SRK-300

(f) Automatic machine for welding of sockets for boiler chambers, type SNK-500

(g) Semi-automatic machine for CO_2-shielded welding (wires up to Ø 1,2 mm), type PSCO-2A

(h) Semi-automatic machine for CO_2-shielded welding (wires up to Ø 2,3 mm), type PSCO-3A

(j) Automatic electro-slag welding machine, type VUS-AS-4.

(9) Automatic pneumatic spot welding machines, typified series:

(a) BP-10A, -20A; -40A; are designed mostly for welding thin plain-grade steel sheets. The welding is carried out either by separate spot welds or by series of spots. The machine is controlled from a separate control box which allows synchronous switching of primary current and choice of welding programmes. Further types (BP-60; -80; -160;) are pneumatic spot welding machines with electronic control with a top output of 500 welds/min. and from 4+4 up to 8+8 mm thickness can be welded.

(b) Welding presses VUS 250 and VUS 1000.1 type are used for mass and lot production of parts of medium and large cross-sections which are welded by the resistance or flash welding process with an automatic working cycle.

(10) This paper does not deal with a detailed description of the particular techniques, but presents only a rough survey of some selected techniques which have been successfully used in this country.

(11) Progressive engineering technology secures a maximum increase in productivity with a minimum physical effort of man, reduces production costs and in the sum has a substantial effect on raising the standard of living, which is the goal of socialist society.

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Agenda Item: D.14

United Kingdom

NON-TRADITIONAL BUILDING MATERIALS IN THE TROPICS

By W.H. RANSOM
of the Building Research Station,
Department of Scientific and Industrial Research

Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

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Non-Traditional Building Materials in the Tropics D.14

by W. H. Ransom

of the Building Research Station,

Department of Scientific and Industrial Research

Introduction

1. Traditional methods of construction depend largely upon the building materials locally available. Thus one finds buildings of timber, bamboo, thatch or earth in those areas of the world where these materials are to hand and of suitable properties.

2. In rural tropical areas great use is still made of such indigenous materials. In urban tropical areas the higher density of building necessitates higher constructional standards in order that the requirements of safety, health and sanitation are met. To help meet this demand for better building, materials of greater durability have been imported or made locally - for example, galvanized steel, cement, precast concrete products and burnt clay ware. These are not new to the tropics - in general they have been in use for more than 25 years. They can be more properly described as conventional materials rather than as traditional or non-traditional ones and do not form the subject of this paper. It deals instead with building materials introduced in tropical areas within the last ten years - certain plastics, emulsion paints, pitch-fibre pipes and aluminium. They originate from industrialized temperate regions; some, moreover, derive from industries other than the building industry.

3. These non-traditional materials may be used in preference to conventional ones because they are cheaper or more readily available. Mostly, however, it is because they possess, or are thought to possess, certain specially desirable properties - for example, good appearance, lightness in weight, strength, elasticity and resistance to impact. They must also be sufficiently durable under normal working conditions, a property that is, unfortunately, difficult to assess. In the past materials were introduced slowly and those proved in practice - usually by trial and error - have become the established materials of today. Present day pressures do not permit this approach. Architects and builders cannot always afford to wait for experience to be their guide; neither can they take too large a risk when introducing new materials. Rightly they seek some technical assurance that the material they aim to introduce will behave satisfactorily in its new environment. It is worth noting that such assurance can rarely be given simply by resorting to accelerated tests in the laboratory which aim in a matter of days to simulate the normal weathering of years. In the experience of the United Kingdom Building Research Station many such tests give quite misleading results. Nevertheless that Station can offer considerable guidance to the prospective user of non-traditional materials in

tropical, (and temperate), regions. This has been achieved often in collaboration with other relevant research organisations - particularly those in Africa, India and Australia - by the study of the fundamental physical and chemical properties of materials; by controlled exposure tests at sites in the United Kingdom and the Tropics; through a knowledge of the building and climatic conditions in many parts of the world acquired by visits and selective surveys; through a systematic study of the weathering agencies that cause change in building materials. The weathering agencies that determine the life of building materials used out of doors are solar radiation, moisture, pollution and biological attack. It is wrong to suppose that these weathering agencies are unique to the Tropics. Primarily, it is variation in their intensity which is responsible for any difference in behaviour of materials exposed in temperate and tropical regions.

Weathering Agencies

4. Solar radiation The main distinction between temperate and tropical regions lies in the levels of solar radiation received. The average annual total solar radiation received at the earth's surface throughout most of the tropical world exceeds 160 k cal per sq. cm. and in the dry areas of N. Africa and Central Australia lies between 200 and 220 k cal per sq. cm. This compares with some 60-80 k cal per sq.cm. per year received in most of the United Kingdom. Though the thermal effects of this solar radiation are best known, the effects of the ultra violet radiation received are also important.

5. High temperatures increase the rate of evaporation of water from materials such as concrete, cement paints, plasters and renderings. Even in humid tropical areas this rate is likely to be at least double that occurring under average temperate conditions; in hot, desert areas it may well be seven times as great. Premature evaporation from such materials leads to cracking, early weakness and poor adhesion. As temperatures rise solvents in paint and plasticisers in plastics are lost more rapidly and thermoplastic materials flow more readily. Unless the manufacturer allows for these effects in the formulation of his product application of the paint could become difficult, unwelcome embrittlement of the plastic would occur and mastics might flow and slump from the joints they were intended to fill. The permeability of plastics films, too, for many organic vapours and for water-vapour approximately doubles for every 18°F rise in temperature.

6. Materials exposed to direct solar radiation commonly reach temperatures far greater than meteorological shade air temperatures. Thus the surface temperatures of dark-coloured building materials will at times exceed 180° F in tropical areas; indeed 150° F and more is not uncommon in England in the summer. Temperature change leads to dimensional change in a material. If the latter is restrained, or has constituents of differing coefficients of thermal expansion, stresses will be set up which may lead to distortion or rupture. The rate at which temperature changes occur is also of importance. The surface temperature of dark materials may change by 100-120° F daily in clear atmospheres; short-period changes on warm surfaces of 66° F in 30 minutes through rain and 30° F in $7\frac{1}{2}$ minutes through cloud passing across the sun have been noted.[1] It is these changes rather than the smaller seasonal changes

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1 Ransom, W. H. Solar Radiation: Thermal Effects on Building Materials, Tropical Building Studies No.3, H.M.S.O. London (1962).

which can be considered of chief importance in causing the breakdown of surfaces. In addition to the purely thermal effects of solar radiation sunlight itself can cause embrittlement, crazing and discolouration of certain organic materials - particularly plastics, paint and rubber. These photochemical effects can also be offset by suitable formulation of the product. For example, while clear polyethylene deteriorates quite rapidly when exposed to sunlight its durability is markedly increased by the addition of a small amount of carbon black during manufacture.

7. Moisture Moisture has a marked and mainly adverse effect upon building materials. Precipitation varies widely throughout the world. In some parts of Algeria and Libya the average annual rainfall is less than one-fifth of an inch and several years may elapse before measurable rainfall is received. In contrast one may quote the well-known example of Cherrapunji, India, where the average annual rainfall is 425 in. nearly half of which occurs in June and July. During equatorial storms the intensity of rainfall can be remarkable; in Suva, Fiji, falls of over 26 in. in a day have been reported.[2] High total rainfall and high intensity falls cause the prolonged and thorough wetting of materials and can erode soft materials; they also keep humidities high and so are conducive to the corrosion of metals. Precipitation may be as hail and in some areas - notably South Africa - hailstorms can be severe enough to damage some roofing materials - notably asbestos-cement sheets and burnt clay tiles.

8. Another source of moisture in building arises through condensation. There are many areas where humidity is high by day and so high at night that even a small drop in the surface temperature of building materials is sufficient to result in heavy condensation upon them. Corrosion of metals is again probable particularly if condensation occurs in crevices; building boards are liable to rot, soften and swell. It is in such areas, too, that mould growth is common causing disfiguration and sometimes decay of building surfaces. Wide fluctuations of relative humidity can occur notably in those tropical areas with pronounced wet and dry seasons, for example, Northern Nigeria and W. Pakistan. These fluctuations, sometimes as much as 75 per cent within a day or two, cause changes in the moisture content of many materials resulting in shrinkage and expansion. Materials based on wood or wood-fibre can be seriously affected and may distort or split.

9. Insects and atmospheric pollution It is in these warm and wet regions, too, that insects abound and many attack organic building materials. By far the greatest damage is caused by termites more popularly, though erroneously, called white ants. Timber and wood-based materials form their principal foodstuff but some plastics are also eaten and damage may be caused to rubber cables and to paint films. Termites that attack building materials are widespread throughout the world though their numbers fall sharply outside the tropics. They are known as far north as latitude 46° N and in Europe are found, for example, in Germany, France and Austria.[3] Subterranean termites

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2 Air Ministry, Meteorological Office. Tables of Temperature, Relative Humidity and Precipitation for the World. Parts 1-V1, H.M.S.O. London (1958)

3 Harris, W. V. Termites. Their Recognition and Control. Longmans, London (1961)

require connection with the soil in order to live and build tubular runways where necessary from the soil to the chosen foodstuff even though this may be at a high level in the building. If these runways are destroyed, or their formation prevented by suitable mechanical barriers, attack will cease. Dry-wood termites, on the other hand, can fly directly into timber and live out their life cycle within it; mechanical barriers are thus ineffective.

10. Brief mention may also be made of pollution. So far, in the Tropics, industrial pollution is slight and less troublesome than in highly industrialized temperate regions. Attack by sea-salts, however - mainly on metals - is severe within half a mile of a coastline and particularly so near surf beaches. In dry, desert areas sand-storms can abrade the softer materials.

Materials

11. Plastics figure prominently amongst the non-traditional materials used in building. Translucent sheets based on polyester and acrylic resins are available to provide daylighting in buildings; polyethylene is fabricated to form pipes for cold water services and in sheet form is used as a vapour barrier; polyisobutylene and phenol-formaldehyde laminates are employed as roof coverings; expanded polystyrene as insulation; polyvinyl chloride as a sheet or tile floor finish. The general properties of some of these plastics, of emulsion paints, pitch-fibre pipes and aluminium cladding are now considered with particular reference to the effects of the weathering agencies already noted.

12. Glass-fibre reinforced polyester sheets and domes. Glass-fibre reinforced polyester sheets and domes are used to admit daylight into a building; they are available in profiles to match those of galvanized steel, asbestos-cement and aluminium. After a year's exposure at a site in Accra, Ghana, sheets showed considerable discolouration of the resin and a decrease in light transmission; the glass fibres had become exposed and picked up dirt. Three years' exposure at the Building Research Station's Garston site in England was required to produce comparable deterioration. There is little doubt that this difference in rate of deterioration is due to the higher humidities and levels of solar radiation in Accra. Yellow pigmented sun shades seen in Singapore after five years' exposure were faded and dirty but otherwise were sound. Termites do not appear to attack this plastic.

13. Polyethylene pipe and sheet. Polyethylene pipe stabilized with carbon black and anti-oxidants is used for cold-water services. It does not corrode, is tough with a high resistance to impact, but needs support at comparatively close centres - for $\frac{1}{2}$ in. diameter piping at every 8 in. on horizontal runs. The coefficient of thermal expansion is high at 12×10^{-5} per °F (cf steel 5.5×10^{-6} per °F) and allowance must be made for this - for example, by coiling the pipe where long lengths occur in spaces liable to marked fluctuation in temperature such as in rooms intermittently air-conditioned. Reports from Australia have been received which state that low-density polyethylene pipe is readily attacked by termites though the more recent high density material has a much greater resistance.[4] No reports are known from other

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[4] Gay, F. G. and Wetherly, A. H. Laboratory Studies of Termite Resistance IV. The Termite Resistance of Plastics. Division of Entomology Technical Paper No.5. Commonwealth Scientific and Industrial Research Organization, Australia. Melbourne (1962)

areas corroborating this but clearly there is a risk involved in the use of low-density polyethylene buried in the ground in termite areas.

14. Polyethylene has a high resistance to the passage of water vapour. In sheet form it is used as a vapour barrier and to cover materials such as freshly cast concrete in order to reduce the rate of evaporation of water from it and so assist curing. Under test conditions thin sheet has shown no serious resistance to penetration by termites. If such penetration occurs in practice efficiency as a vapour barrier would be markedly reduced. Transparent polyethylene has a short life when exposed to the sun and the black, opaque sheet is recommended. Polyethylene is highly resistant to fungal growth and when this occurs it is generally confined to surface dirt on the sheet or pipe.

15. Phenol-formaldehyde resin. Phenol-formaldehyde resin is used in the manufacture of a pressure-bonded laminate consisting of vegetable fibres impregnated with the resin. The laminate is shaped to give a tough, rigid and durable corrugated roofing sheet. This is made with the same standard profiles and fixed in the same way as the more traditional corrugated sheets of asbestos-cement and galvanized steel. Examples exposed for more than seven years have been seen in climates as widely different as those of Kuwait and Trinidad, which, save for a loss in gloss and some slight fading were in excellent condition. Sheets are not attacked by termites and do not support mould growth.

16. Expanded phenol-formaldehyde is available for thermal insulation. Exposure tests[5] have shown that specimens show little change, other than in colour, under conditions varying from hot desert to jungle undergrowth.

17. Polystyrene. A principal use for polystyrene has been in expanded form for thermal insulation. Slabs of the material weighing only 1-1½ lb. per cu. ft., but surprisingly rigid for such a low density, have been used mainly for roof insulation. Because slabs have a low water absorption it has been suggested from time to time that they might be used as insulation and waterproofing combined. Such a use is not recommended, however, for the permeability to water is appreciable; moreover, when exposed to sun and rain deterioration is rapid. In practice it is usual to cover the slabs with a screed and then with a normal water-proofing system. Protected in this way expanded polystyrene is durable and it is very unlikely that the maximum working temperature of 180° F would be reached. It appears not to be attacked by termites.

18. Emulsion paints. Emulsion paints based on polyvinyl acetate (pva) have found acceptance in tropical areas. They have many desirable properties. As they are based on water, clean pastel tints can be produced which dry quickly; slightly damp surfaces can be painted, the porous paint film allowing moisture to be transmitted through it. Application is easy with best results being obtained on porous materials such as concrete, brick and plaster. Adhesion in multiple coats is good and flaking seldom occurs.

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5 Ministry of Supply. Reports on Plastics in the Tropics. 1.Expanded Plastics. H.M.S.O. London (1951)

19. Though their fungal resistance is high, pva emulsion paints are not immune to mould growth. This is particularly likely where air-conditioning results in the condensation of warm, moist air on painted surfaces.[6] Efflorescence or lime bloom, appearing as a white deposit, is common in both tropical and temperate climates where the emulsion paint is applied over materials containing cement or lime such as concrete block and cement rendering. It is particularly marked where sea-sand has been used in their production. Emulsion paints based on pva are prone to chalking when used out of doors.

20. Pitch-fibre pipes. Pitch-fibre pipes are made from cellulose fibres impregnated under vacuum with coal-tar pitch. They are tough and light in weight, an 8 ft pipe of 6 in. diameter weighing only 40 lbs. compared with about 160 lbs. for a stoneware pipe of similar size. They are of smooth bore and have tapered ends; joints are made by driving pitch-fibre couplings on to the pipe by hand. As no jointing compounds are required there is nothing to cause obstruction in the pipes; neither should the entry of tree roots prove possible. Pipes are resistant to soil sulphates, to sewage, to termites and to fungal attack. They must not be used to carry hot water continuously nor organic pitch solvents as, for example, from a laboratory. Though they behave well underground it is inadvisable to extend their use above-ground if exposed to the sun. The high surface temperatures reached, together with the effects of sunlight, could lead to distortion and breakdown. For those reasons they should be stored under cover.

21. Aluminium. Aluminium is now being widely used for roofing, wall cladding and for the framework of 'curtain-wall' buildings. Alloys are available for each of these specific purposes. Self-supporting sheets are normally of an aluminium-manganese alloy, are light and strong and used mainly in 20, 22 or 24 S.W.G. Under severe coastal conditions exposure tests have indicated that an unpainted 22 gauge sheet should have a useful life of some 25-30 years. When aluminium is in direct contact, in the presence of moisture, with many other materials - for example, with concrete, lime, timber, lead and copper - electrolytic corrosion can occur. So may it, too, if the building design is such that crevices are formed whereby rain or condensation can lodge against the sheet for long periods. Such attack is particularly likely in tropical marine atmospheres. These aggressive conditions should be nullified by the use of non-rotting chromate insulating tapes or bitumen felt interposed between the aluminium and the second material, by using aluminium or galvanized steel fixing accessories, by good design and by packing any crevices with a barium chromate jointing compound. New aluminium is specularly reflective and can cause unpleasant and troublesome glare in bright sunshine. Sheets with an embossed finish or etched by the manufacturer can be obtained which do not cause this annoyance. For roofs of low pitch, proprietary sheets are available which have no fixing holes exposed to the weather and with more pleasing profiles than the standard corrugated sheets. They are particularly valuable in areas of high rainfall.

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6 Building Research Station. Paint Topics. Overseas Building Notes No. 80. H.M.S.O. London (1962)

22. Aluminium, sometimes anodised and dyed, is used for the framework of curtain walling, for panels, and for window frames. Apart from fading of the dye it has given, and should continue to give, good service.

Conclusion

23. The materials described are now being used in the tropics often in regions with widely differing climates; there are others which are being used or will be in the future - such materials, for example, as silicone waterproofers, thiokol mastics, asbestos-cement with epoxy resin finish, and polyurethane floor lacquers. All these materials have been manufactured and developed by industry in highly industrialized temperate regions. Their likely behaviour for building in less developed temperate and tropical areas can now be assessed, through the application of science, by such organizations as the United Kingdom Building Research Station and similar bodies elsewhere. While it would be wrong to use such materials indiscriminately their introduction need not, therefore, be unduly retarded by uncertainty.

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ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

SUMMARY

Agenda Item: D.14

United Kingdom

NON-TRADITIONAL BUILDING MATERIALS IN THE TROPICS

By W.H. RANSOM,
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and Industrial Research

Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

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Non-Traditional Building Materials in the Tropics D.14

by W. H. Ransom

of the Building Research Station,

Department of Scientific and Industrial Research

Summary

1. Traditional methods of construction depend upon the building materials available locally and in rural tropical areas great use is still made of indigenous materials such as bamboo, thatch and earth. In urban tropical areas the higher constructional standards required necessitate using materials of greater durability. Some plastics, emulsion paint, pitch-fibre pipes and aluminium are considered - all introduced to urban tropical areas within the last ten years. Through the study of the weathering agencies that cause change, and the physical and chemical properties of such non-traditional materials, the United Kingdom Building Research Station can now offer considerable guidance as to their likely behaviour.

2. These weathering agencies are solar radiation, moisture, atmospheric pollution and biological attack. They are not unique to the Tropics; it is variation in their intensity which is mainly responsible for any differences in the behaviour of materials exposed in temperate and tropical regions.

3. Materials exposed to direct solar radiation commonly reach temperatures far greater than shade air temperature. High temperatures increase the rate of evaporation of water from concrete, plasters and renderings and of solvents from paints; plasticisers in plastics are lost more rapidly, thermoplastic materials flow more readily and the permeability of plastics films increases. Temperature change can result in stresses leading to distortion or rupture. Short period changes through rain or through cloud passing across the sun are particularly responsible for the breakdown of surfaces. Sunlight can cause the embrittlement, crazing and discolouration of plastics, paint and rubber.

4. High total and intensity rainfall can erode soft materials and are conducive to the corrosion of metals; hail can damage brittle roofing materials. Condensation - particularly in crevices - can also corrode metals and may cause building boards to rot, soften or swell. Wide fluctuations of relative humidity can cause materials based on wood or wood-fibre to distort or split.

5. In warm, wet regions insects abound and considerable damage is caused by termites to wood-based materials; plastics, rubber cables and paint films may also be attacked. In the Tropics industrial pollution is at present slight but attack by sea-salts is severe near surf beaches; in dry areas sandstorms can cause damage through abrasion.

6. Glass-fibre reinforced polyester sheets and domes are used to admit daylight into a building. Tropical exposure results in discolouration and a decrease in light transmission. Polyethylene pipe is used for cold-water services. It does not corrode and is tough; allowance must be made for its high coefficient of thermal expansion. Polyethylene sheet is used as a vapour barrier and as a curing membrane for concrete. Black opaque sheet has a greater resistance to solar radiation than clear sheet. Termites are known to attack both low-density polyethylene pipe and sheet. Phenol-formaldehyde resin is used in the manufacture of tough, rigid and durable corrugated roofing sheets which discolour somewhat upon exposure but are neither attacked by termites nor support mould growth. Expanded phenol-formaldehyde and expanded polystyrene are available for thermal insulation. The latter has a low water absorption but its permeability is appreciable; its resistance to solar radiation is not high. Protected from sun and rain it is durable and appears not to be attacked by termites.

7. Emulsion paints based on polyvinyl acetate produce clean pastel tints which dry quickly. Best results are obtained on porous surfaces such as plaster; slightly damp surfaces can be painted, adhesion is good and flaking seldom occurs. They are resistant, though not immune, to mould growth and lime bloom is common where the emulsion paint is applied to materials containing cement or lime.

8. Pitch-fibre pipes are tough, light in weight and easily joined together without the aid of jointing compounds. They are resistant to soil sulphates, sewage, termites and fungal attack but not to continuous hot water or pitch solvents. They behave successfully underground but could deteriorate and distort if exposed to the sun for long periods.

9. Aluminium alloy is used for roofing, wall cladding and for the framework of "curtain-wall" buildings. In direct contact with many other materials in the presence of moisture electrolytic corrosion can occur; so may it, too, if the building design is such that crevices are formed where water can lie. Such aggressive conditions should be prevented. Glare can be troublesome with new sheets in bright sun but embossed or etched sheets do not cause this annoyance. Special sheets having concealed fixings are available for the low-pitch roof.

10. The materials discussed have been made and developed by industry in temperate regions. Their likely behaviour in less developed tropical areas can now be assessed through the application of science by such organizations as the United Kingdom Building Research Station.

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Agenda Item: D.4.2.

Sweden

A NEW METHOD OF ENSILING FOODSTUFFS AND FEEDSTUFFS OF VEGETABLE AND ANIMAL ORIGIN

By Ragnar NILSSON
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Royal Swedish Agricultural College
Ultuna

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A New Method of Ensiling Foodstuffs and Feedstuffs of Vegetable and Animal Origin.

By

Ragnar Nilsson and Conrad Rydin
Royal Swedish Agricultural College and National Agricultural Research Centre

In silage-making by purely biological processes the basis of positive conservation of the organic material is a lactic-acid fermentation which sets in so rapidly and is so intense that it extinguishes all other, undesirable, microbial or enzymatic activities. In order to make possible such a lactic-acid fermentation, relatively large quantities of carbohydrates fermentable by lactic-acid bacteria are required. In many types of feed and foodstuffs the lack of such carbohydrates often limits the production of an efficient lactic-acid fermentation. Examples of such materials are lucerne, clover, brewer's grains, potatoes and, above all, animal products such as meat, fish, blood and slaughterhouse waste.

The types of lactic-acid bacteria, which appear to be responsible for most of the lactic-acid production, ferment different types of sugar, including certain pentoses (xylose, arabinose) as well as hexoses (glucose, fructose, galactose) and disaccharides (sucrose, maltose), producing chiefly lactic acid but also smaller quantities of acetic acid. Polysaccharides such as dextrin and starch are considerably more difficult to ferment than these sugars.

In ensiling experiments with green fodder, in which different enzyme preparations with high amylase and cellulase activities, either alone or together with cereal meal, were added to material of low sugar content, it was possible to hydrolyse to a high degree polysaccharides not fermentable by lactic acid bacteria into fermentable sugar, so that a sufficient lactic-acid fermentation was produced to preserve the fodder properly. A meal of enzyme-rich malt produced by special methods from 6-row barley proved to be particularly suitable for this purpose. Of particular interest is the ability of the enzymes in malt to attack and hydrolyse the raw native starch. In this hydrolysis α-amylase is an active enzyme. This enzyme does not exist in ungerminated grain but is formed during germination.

Besides the effect of the carbohydrases in the malt, the addition of the mixture of enzyme-rich malt-cereal meal (usually mixed in the ratio of 1:5) promotes the lactic-acid fermentation in the silage, owing to the fact that the meal mixture has a high content of various Lactobacillus species and therefore the addition of meal is accompanied by substantial inoculation with desirable micro-organisms. The ensiling malt has a high content of certain free amino acids (valine, leucine, isoleucine, threonine, methionine, glutamic acid, tryptophane, phenylalanine) and certain B vitamins (riboflavine, B_6, pantothenic acid, biotin), which the heterotrophic lactic-acid bacteria require for their growth. After the addition of this malt-cereal mixture the lactic-acid bacteria in the silage seem to have optimal conditions as regards the substrate, which leads to rapid and substantial lactic-acid fermentation and thereby a good result in the ensiling. We would point out that, even without the addition of malt, meal of various kinds of cereal contains large amounts of lactic-acid bacteria and in addition smaller amounts of carbohydrates fermentable by lactic-acid bacteria and also growth factors for these

bacteria. The addition of large quantities of cereal meal, without the simultaneous addition of malt, may therefore yield good results. However, the large quantities of cereal which are required in this connection and the uncertainty involved in the use of this supplement limit to a great extent the use of cereal meal alone as a supplement in ensiling.

Good-quality silage is characterized by low figures for ammonia nitrogen as a percentage of total nitrogen (NH_3-N of total N); this figure should be less than about 12 and furthermore butyric acid must only occur in insignificant quantities.

The losses during fermentation are greatly limited if vigorous lactic-acid fermentation is started rapidly and also if the effluent is not drawn off but allowed to remain in the silo, thereby being utilized as fodder. Silage appetizing to cattle has a high content of lactic acid and often some sugar also.

The results of some ensiling experiments with the addition of malt-cereal meal to various kinds of fodder will now be presented. The ensilings were carried out on a laboratory scale in silos of stainless steel containing 12-16 kg green fodder or brewer's grains and in smaller silos of glass containing 2-3 kg fish, meat, blood, rumen contents, rumen wall and raw potatoes. Effluent was not drawn off.

Table 1.

Table 1 shows analyses of lucerne-grass silage, partly without supplement and partly with the addition of various amounts of barley meal or mixtures of malt- and barley meal. It is clear from these analyses that the silages without supplement and with 3 % or 4.5 % of barley meal were a complete failure; 6 % or 9 % of barley meal improved the quality, though not to such an extent that the silage could be regarded as satisfactory. The supply of sugar fermentable by the lactic-acid bacteria was not sufficient to achieve sufficiently intense lactic--acid fermentation. The addition of 3 % or 4.5 % of mixtures of malt- and barley meal resulted in first-class silage. The enzymes in the malt attacked and sufficiently hydrolysed the starch in the meal mixtures, so that an adequate quantity of sugar was available for the lactic-acid bacteria. In the silages with a malt supplement lactic-acid fermentation greatly predominated, thus largely precluding the processes of decomposition and butyric-acid fermentation. Silages with low contents of butyric acid often have low contents of spores of butyric-acid bacteria, a fact which may be of importance when silage is fed to cows whose milk is used in the production of certain kinds of cheese.

Table 2.

Table 2 shows analyses of very wet clover silage, ensiled partly without supplement and partly with the addition of either malt-cereal meal of chopped straw or these two supplements in mixtures. Chopped straw was mixed with the fodder to absorb the effluent. The analyses show very clearly how the malt-cereal meal has favourably affected the course of fermentation. The silage quality was first-class, independent of whether the malt-cereal meal was added alone or in a mixture with equal parts of chopped straw. When both these supplements are used, no effluent need be drawn off, thus avoiding large losses of nutrients from the fodder and a heavy contamination of the surrounding water recipients.

As regards vegetable matter, brewer's grains and raw potatoes have been successfully ensiled with the addition of malt-cereal meal. For both these kinds of fodder about 5 % of malt-cereal meal (1:5) is required for good results.

Table 3.

Table 3 shows analyses of silage of brewer's grains. This silage was first-class when 4.8 % of malt-barley meal was used. The hydrolysis of polysaccharides to fermentable sugar, as well as the fermentation of the sugar to lactic acid, was considerable in these silages. Barley meal alone did not yield anywhere near the same good results as similar quantities of malt-barley meal.

Animal material such as fish (cod and herring), meat, rumen contents, rumen wall, blood and the like have been successfully ensiled by admixture of malt--cereal meal to the finely ground, fresh material. The quantities of meal used for these kinds of fodder are 25-33 % (malt/cereal ratio 1:5) or 33-50 % (malt/cereal ratio 1:10), with ensiling at 20-28° C. Within this temperature range the material can safely be kept for 4 weeks. After that lower storage temperatures should be aimed at. As far as is known up to the precent, however, there is no objection to using the material even before complete fermentation. The lactic--acid fermentation is essential when it is a question of conserving the material, but does not seem to be necessary to make it suitable as a feed-stuff, though it seems possible to foresee that this fermentation may be of great importance as regards material infected with pathogenic germs. Silage made with the kinds of fodder mentioned is easy to dry. The result of ensiling experiments with animal material will now be presented.

Table 4.

Table 4 shows analyses of silage of small Baltic herring, which, after being ground in an ordinary meat-mincer were ensiled partly without and partly with an addition of either oatsmeal or malt- and oatsmeal in various mixing ratios and quantities. When sufficient amounts of the mixture of malt- and oats-meal were added to the material, the quality of the silage was first-class. Silage with this supplement was incomparably better than silage with a similar supplement of oatsmeal alone.

Table 5.

Table 5 shows analyses of silages of small Baltic herring with malt-barley meal (1:5) in various quantities and ensiled at different temperatures. Fermentation temperatures of 20-28° C throughout yielded first-class silage. At 37° C the quality was poorer. It is nevertheless obvious that there is a possibility of utilizing sensitive organic material by this method even under tropical conditions.

The usefulness of the method, as concerns animal material, may be illustrated by the following Table 6.

Table 6.

This table shows silage analyses of animal material which may possibly be used as food for human consumption. As is evident, very large quantities of the malt-cereal mixture were used. This was in order to guarantee a very rapid lactic--acid fermentation and thereby an effective inhibition of the processes of decomposition and consequently toxin formation. The very high contents of sugar in these silages indicate that probably unnecessarily large quantities of the meal mixture were used.

Dried silages made from cod-fish, meat and blood, using our method, have been investigated bacteriologically by the Swedish National Institute of Public Health and found to be unobjectionable as regards human consumption. Further ensiling experiments with animal products, including infection experiments with pathogenic bacteria, must certainly be carried out before such silage can be recommended for human consumption.

Table 7.

Table 7 shows the results of ensiling the contents of the rumens of slaughtered cows. As the table shows, malt-cereal meal (1:5), together with straw meal, was used as a supplement.

The rumen contents of slaughtered cows vary in weight between 60 and 90 kg per animal. The dry-matter content is low but the content of vitamins (thiamine, riboflavin, nicotinic acid, B_{12}) and valuable protein from micro-organisms is relatively high.

It is clear from the table that the non-fermented rumen contents held a few tenths per cent of lactic acid and butyric acid. By the addition of malt-cereal meal a satisfactory silage for animal feeding is obtained.

Silage made from the contents of the rumens of slaughtered cows which had been at pasture was fed fresh to hens. Dried and ground silage made from the contents of the rumens of slaughtered cows which had been stable-fed was fed to pigs. Both these kinds of animal consumed the silages with avidity.

Small-scale feeding experiments have been going on for a year at the Institute of Microbiology with hens (2 x 24), which are fed with fresh or dried silage made from clover-grass, rumen contents, rumen wall, fish and blood.

Table 8.

Table 8 shows the chemical composition of the four kinds of silage of animal origin which are at present being used in the feeding ration and the supplements used in the ensiling. These silages were dried in a hay drier and were ground into meal before feeding.

The hens have at present free access to the following meal mixture:

NaCl	0.2 %	Dried silage made from	
Vitamin A, D, E, preparations	0.2 %	1 part rumen wall +	
Yeast powder	0.4 %	4 parts rumen contents	2.0 %
$CaHPO_4$	0.6 %	Dried silage made from blood	3.0 %
$CaCO_3$	0.6 %	Dried silage made from rumen wall	4.0 %
Soybean meal	4.0 %	Dried silage made from herring	5.0 %
		Oats and barley meal (1:1)	80.0 %

In addition, the hens receive daily about 15 g of silage made from clover-grass ensiled with 6 % of malt-cereal meal (1:5) + 6 % of wheat bran, and moreover oyster shell and water. A few cases of lymphomatosis have occurred, but otherwise the hens' health is good. The laying percentage is 60-70 %. It has not been possible to demonstrate any fishy taste in the eggs or in the carcases. The quality of the egg shell is good.

Our ensiling method, using vegetable crops, has been applied full-scale under practical conditions on Swedish farms in althogether about 100 ensilings during the past 5 years with good results. In a small number of experiments the fish silage has been fed to pigs and turned out attractive to them.

Table 1. The effect of barley meal and malt-barley meal on the fermentation process in ensiling a crop of lucerne-grass. Ensiling time, 8 weeks. Temperature, 28°C.

Supplements	pH	Dry matter %	Sugar %	Lactic acid %	Butyric acid %	NH_3-N of tot. N %
Control No Supplements	5.6	17.1	0.09	0.7	0.82	30.5
Barley meal 3.0 %	5.3	17.8	0.08	0.6	0.89	23.9
" " 4.5 "	5.8	14.7	0.08	0.5	1.17	24.8
" " 6.0 "	5.0	19.8	0.1	1.9	0.46	13.4
" " 9.0 "	5.1	19.7	0.05	1.1	0.66	15.5
Malt meal 0.5% + barley meal 2.5%	4.3	19.1	0.23	2.7	0.07	9.3
" " 0.5" + " " 4.0"	4.2	18.5	0.26	3.3	0.01	9.3
" " 0.75" + " " 2.25"	4.2	19.6	0.20	2.7	0.01	8.7
" " 0.75" + " " 3.75"	4.3	18.2	0.46	3.0	0.04	9.0

Table 2. The effect of malt meal and cereal (oats-barley) meal (1:5) and chopped straw, alone or in a mixture, on the fermentation process in ensiling a clover crop. Ensiling time, 6 weeks. Temperature, 28°C.

Supplements	pH	Dry matter %	Sugar %	Lactic acid %	Butyric acid %	NH_3-N of tot. N %
Control. No supplements	5.8	11.8	0.05	0.3	1.07	41.8
Malt-cereal meal (1:5) 3.0 %	4.5	13.4	0.06	1.9	0.01	12.2
" " " 4.5 "	4.1	14.6	0.17	2.5	0.01	11.1
" " " 6.0 "	3.9	13.8	0.46	2.8	0.01	9.5
Chopped straw 3.0 %	5.7	12.2	trace	0.3	1.07	78.1
" " 4.5 "	5.7	11.4	trace	0.2	1.28	86.5
" " 6.0 "	5.9	12.4	trace	0.2	1.20	85.7
Malt-cereal 3.0 % + straw 3.0 %	4.1	12.6	0.11	2.3	0.01	8.8
" " 4.5 " + " 4.5 "	4.1	14.1	0.11	2.3	0.01	9.7
" " 6.0 " + " 6.0 "	3.9	15.4	0.42	3.2	0.01	8.3

Table 3. The effect of barley meal and malt-barley meal on the fermentation process in ensiling brewer's grains. Ensiling time, 8 weeks. Temperature, 28°C.

Supplements	pH	Dry matter %	Sugar %	Lactic acid %	Butyric acid %
Control. No supplements	4.4	21.2	0.16	0.5	0.87
Barley meal 2.4 %	4.3	20.0	0.13	0.5	1.25
" " 4.8 "	4.3	21.8	0.10	0.8	1.03
" " 7.2 "	3.8	24.0	0.11	1.6	0.12
Malt meal 0.4 % + barley meal 2.0 %	4.6	18.9	0.06	0.4	1.19
" " 0.6 " + " " 3.0 "	3.8	22.1	0.10	1.6	0.13
" " 0.8 " + " " 4.0 "	3.6	22.6	0.15	1.9	0.01
" " 1.0 " + " " 5.0 "	3.5	23.6	0.55	1.9	0.01
" " 1.2 " + " " 6.0	3.6	24.0	0.85	2.5	0.01

Table 4. The effect of oats meal and malt-oats meal on the fermentation process in ensiling small Baltic herring. Ensiling time, 4 weeks. Temperature, 28°C.

Supplements	pH	Dry matter %	Lactic acid %	Butyric acid %	NH_2-N of tot. N %
Control. No supplements	7.3	14.9	0.6	2.91	55.4
Oats meal 20 %	6.6	32.3	0.5	3.18	38.8
" " 25 "	5.5	35.8	3.3	1.05	25.4
" " 30 "	4.9	46.2	4.6	0.04	15.9
Malt meal 2 % + oats meal 18 %	4.5	34.6	5.7	0.01	14.2
" " 2 " + " " 23 "	4.4	34.2	5.7	0.01	13.3
" " 2 " + " " 28 "	4.4	45.3	4.9	0.01	11.3
Malt meal 4 % + oats meal 16 %	4.6	34.4	5.4	0.01	12.6
" " 4 " + " " 21 "	4.5	37.7	5.4	0.01	12.3
" " 4 " + " " 26 "	4.5	45.4	5.0	0.01	10.8

Table 5. The effect of malt-barley meal on the fermentation processes in ensiling small Baltic herring. Ensiling time, 4 weeks. Temperature 20°, 28° or 37° C.

Temp. Centi-grades	Supplements	pH	Sugar %	Lactic acid %	Butyric acid %	NH_3-N of tot. N %
28	Control. No supplements.	7.1	-	0.6	1.98	43.9
20	Malt meal 4 % + barley meal 20 %	4.3	3.5	5.2	0.01	8.0
	" " 6 " + " " 30 "	4.4	5.4	4.8	0.01	7.4
	" " 8 " + " " 40 "	4.4	6.5	4.7	0.01	7.6
28	Malt meal 4 % + barley meal 20 %	4.3	3.4	5.0	0.01	8.9
	" " 6 " + " " 30 "	4.4	5.1	4.8	0.01	7.7
	" " 8 " + " " 40 "	4.3	6.9	4.5	0.01	7.7
37	Malt meal 4 % + barley meal 20 %	4.2	1.0	5.9	0.23	12.8
	" " 6 " + " " 30 "	4.1	2.3	5.5	0.12	10.3
	" " 8 " + " " 40 "	4.1	4.4	5.0	0.04	9.9

Table 6. The effect of malt meal and cereal (oats-barley) meal (1:5) on the fermentation process in ensiling cod-fish, beef and pigs' blood. Ensiling time, 7 - 10 days. Temperature, 28° C.

Material (ground)	Malt-cereal meal (1:5)	pH	Sugar %	Lactic acid %	Butyric acid %	NH_3-N of tot. N %
Cod fish (with skin & bone)	50 %	4.5	4.68	3.8	0.0	6.1
" " "	50% + NaCl 2.25%	4.5	5.54	3.8	0.0	6.3
Cod fish (filet)	33 %	4.2	5.46	3.4	0.0	6.7
" "	50 "	4.6	6.06	4.0	0.0	8.5
Beef meat	33 %	4.2	4.10	2.3	0.0	1.8
" "	33% + NaCl 1.25%	4.2	4.40	3.2	0.0	2.3
Blood (pigs)	21 %	4.0	2.26	3.9	0.01	2.0
"	50 "	4.1	6.50	3.5	0.0	1.8

Table 7. The effect of malt meal and cereal (oats-barley) meal (1:5) and straw meal on the fermentation process in ensiling rumen contents from slaughtered cows. Ensiling time, 10 days. Temperature, 28° C.

Supplements	pH	Dry matter %	Sugar %	Lactic acid %	Butyric acid %	NH_3-N of tot. N %
Control. No supplements. Not fermented	6.9	11.3	0.08	0.2	0.15	5.4
Control. No supplements. Fermented	5.6	9.6	trace	0.2	0.32	25.3
Malt-cereal-meal (1:5) 6 % + straw meal 6 %	4.3	16.5	0.11	1.8	0.36	13.6
Malt-cereal-meal 9 % + straw meal 9 %	4.2	19.1	0.19	2.1	0.36	12.7
Malt-cereal-meal 12 % + straw meal 12 %	4.0	22.4	0.88	2.3	0.34	11.6

Table 8. Chemical composition of dried silages of animal origin and soybean meal and oats-barley meal (1:1) used in the feeding ration for the hens.

Material	Supplements	Percentage of dry matter				
		Crude protein	Crude fat	N-free extr.	Plant fiber	Ash
Blood	Malt-cereal (1:10)25% + wheat bran 25 %	32.5	3.3	46.2	6.5	11.5
Herring	Malt-cereal (1:10)60% + NaCl 1 %	28.4	9.0	47.9	4.7	10.0
Rumen wall	malt-cereal (1:10)25% + wheat bran 25%	29.3	10.0	47.6	7.2	5.9
Rumen wall 1 part + rumen cnt 4 parts	Malt-cereal (1:10)25% + wheat bran 25 %	19.1	7.7	54.2	11.7	7.3
Soybean meal (extr)		51.7	0.7	34.1	6.3	7.2
Oats-barley meal (1:1)		13.1	4.0	73.3	6.8	2.8

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UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

SUMMARY

Agenda Item: D.4.2

Sweden

A NEW METHOD OF ENSILING FOODSTUFFS AND FEEDSTUFFS OF VEGETABLE AND ANIMAL ORIGIN

By Ragnar NILSSON
and Conrad RYDIN

Royal Swedish Agricultural College,
Ultuna

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A New Method of Ensiling Foodstuffs and Feedstuffs of Vegetable and Animal Origin.

By

Ragnar Nilsson and Conrad Rydin

Royal Swedish Agricultural College, Ultuna.

Summary

In ensiling both vegetable and animal material, first-class silage is obtained if sufficient quantities of a meal mixture consisting of enzyme-rich malt and cereal, in the mixing ratio of 1:5 or 1:10, are added to the fresh, finely divided fodder. This meal mixture supplies lactic-acid bacteria, together with the amino acids and vitamins which these bacteria require for their growth, and, above all, carbohydrates (starch), which are hydrolysed by the enzymes in the malt to sugar fermentable by the lactic-acid bacteria.

In ensiling forage crops with malt-cereal meal, it was found that the effluent can safely be kept in the silo by absorption in chopped straw mixed with the green fodder, thus avoiding large losses of nutrients from the fodder and rather heavy contamination of the surrounding water recipients.

Dried silage of fish, beef and blood, ensiled with malt-cereal meal, proved to be unobjectionable from a sanitary point of view.

Hens were fed for a year with dried silages made from rumen contents, fish and pigs' blood. Their state of health and egg production were good; the eggs and carcasses were of good quality and did not give any unpleasant taste or smell.

This new means of preserving organic matter is so simple that it can be practised at sea, using absolutely fresh fish which is directly ground together with the malt-cereal meal. There also appears to be a possibility of producing, after the necessary modifications, a cheap protein of biologically full value for direct human consumption.